

HIGH-PRECISION O-ISOTOPE MEASUREMENTS IN VIGARANO CAIS: SLOPE 0.94, AND COMMON PRESENCE OF ^{16}O -RICH MELILITE AND ANORTHITE

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Introduction: CAIs from most primitive chondrites have uniformly ^{16}O -rich compositions among all phases, and similar to that of the Sun, suggesting formation in a gas of ~ solar composition [1]. However, CAIs from CV3 chondrites are internally heterogeneous: on a three-isotope O diagram, melilite and anorthite are generally ^{16}O -depleted relative to spinel and pyroxene and collectively define a slope of ~1 [2]. The origin of this heterogeneity and the precise slope of the mixing line remain uncertain. New analyses of the O-isotope compositions of individual phases in four pristine (relative to Allende) Vigarano CAIs, measured in multicollection mode using the UH Cameca ims 1280 (see [3] for details), shed new light on the nature of the CV3 mixing line.

Results: CAI F8 is a fluffy Type A in which hibonite and spinel are uniformly ^{16}O -rich at $\delta^{17,18}\text{O} = -43\text{‰}$. Melilite is isotopically heterogeneous, $\delta^{17,18}\text{O} = -11\text{‰} - +3\text{‰}$. The pyroxene is unique, being uniformly ^{16}O -depleted at $\delta^{17,18}\text{O} = 5$ to 8‰ , and yet it contains 15–19 wt. % TiO_2 and 65% of the Ti is Ti^{3+} . CAI F6 is a compact Type A in which not only the pyroxene and spinel but also most of the melilite are uniformly ^{16}O -rich, $\delta^{17,18}\text{O} = -39$ to -44‰ . Only one melilite analysis is ^{16}O -depleted, $\delta^{17,18}\text{O} = -17\text{‰}$. CAI F1 is a Type B2, in which fassaite and spinel are uniformly ^{16}O -rich at $\delta^{17,18}\text{O} = -40$ to -43‰ . Anorthite is variably ^{16}O -enriched, $\delta^{17,18}\text{O} = -20$ to -45‰ . CAI F4 is a complex Type A-B-C hybrid that has experienced multiple melting episodes. That complexity is reflected in the large isotopic heterogeneity of all phases: pyroxene $\delta^{17,18}\text{O} = -9$ to -43‰ ; spinel $\delta^{17,18}\text{O} = -35$ to -43‰ ; anorthite $\delta^{17,18}\text{O} = -12$ to -44‰ ; melilite $\delta^{17,18}\text{O} = -13$ to 16‰ .

Discussion: One interpretation of the internal O-isotope heterogeneity is that the external gas reservoir was changing in composition while the CAI melts slowly cooled. Our observation that plagioclase (one of the last phases to solidify in most CAI melts) is ^{16}O -rich along with the spinel argues against such an idea. Instead, the observed correlation between the degree of ^{16}O -depletion in melilite and anorthite in Vigarano vs. Allende CAIs suggests fluid-rock interaction played an important role in O-isotope exchange. The original gas spectrometry data [4] gave a mixing line slope of about 0.94 (± 0.02), but [5] argued that the Allende mineral separates analyzed by [4] were not pure and contained secondary phases that tended to skew the line to a lower slope. The laser-ablation ICP-MS data of [5] seemed to indicate that the slope was actually 1.0. However, our high-precision data have even finer spatial resolution than those of [5] and our Vigarano CAIs mostly lack secondary phases (which we avoided); collectively our data yield a slope of 0.94 ± 0.02 . We see no evidence for the existence of the Young-Russell line [5].

References: [1] Krot A. et al. 2010. *ApJ* **713**, 1159–1166. [2] Scott E. and Krot A. 2003. *Treatise in Geochemistry* V. 1, 143–200. [3] Makide K. et al. 2009. *Geochim. Cosmochim. Acta* **73**, 5018–5050; [4] Clayton R. et al. 1977. *Earth Planet. Sci. Lett.* **34**, 209–224; [5] Young E. and Russell S. 1998. *Science* **282**, 452–455.